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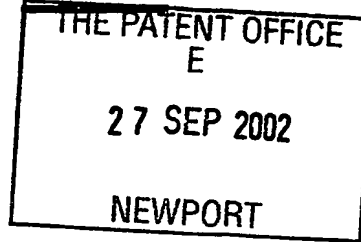
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1/77

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1. Your reference

27 SEP 2002

IPD/P1326

28SEP02 E751663-1 D01891

P01/7760 0.00-0222497.0

2. Patent application number

(The Patent Office will fill in this part)

0222497.0

3. Full name, address and postcode of the or of each applicant (underline all surnames)

THE SECRETARY OF STATE FOR DEFENCE  
DSTL  
Porton Down  
Salisbury, Wiltshire, SP4 0JQ UK

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

GB

6997670005

4. Title of the invention

Respirator

5. Name of your agent (if you have one)

Skelton, Stephen Richard

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

D/IPR Formalities Section  
Poplar 2  
MoD Abbey Wood #2218  
Bristol  
BS34 8JH

Patents ADP number (if you know it)

7827108002

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Country

Priority application number  
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Number or earlier application

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Yes

- a) any applicant named in part 3 is not an inventor, or
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Description 13

Claim(s) 3

Abstract 1

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Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77) 1

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11. I / We request the grant of a patent on the basis of this application.

Signature

SR Skelton

Date 27/09/2002

12. Name and daytime telephone number of person to contact in the United Kingdom

J Northcott  
011791 32860

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# DUPLICATE

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## Respirator

The present invention relates to the field of respirators, particularly, but not exclusively, those used as protection against toxic chemical and biological agents.

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Respirators were first developed in response to the use of chemical warfare agents in the First World War. Nearly all respirators have several common features; a seal suitable for forming a seal against the face, thus providing a cavity into which air is inhaled via a filter that removes noxious materials from the inhaled air. The seal prevents ingress of ambient, potentially foul air into the cavity and thus into the lungs of the wearer. Air is drawn into the cavity either by the negative pressure caused by inhalation of the wearer or by the use of a positive pressure exerted, for example, by a pump. The respirators also normally comprise some sort of eyepiece.

US4574799 and GB1587812 describe a respirator comprising both an oronasal mask and an outer face-sealing mask, wherein, in use, the oronasal mask forms a seal around the oronasal region of the face of the wearer and defines a cavity between itself and the outer mask such that substantially no pressure difference forms between the ambient atmosphere and the cavity between the oronasal mask and the outer mask that would allow ingress of ambient air into the cavity between the oronasal and outer masks. Such masks isolate the breathing volume from the cavity formed between the seal of outer mask and face and allows for compensation in the drop in pressure during inhalation that may lead to ingress of unwanted material via disrupted seal.

WO02/11816 discloses a dual cavity respirator similar to those disclosed in US4574799 and GB1587812. The respirator of WO02/11816 also comprises an ocular mask in gaseous communication with the oronasal mask. The ocular mask protects the eyes against potential damage should foul air enter the cavity between the outer mask and the oranasal mask. However, several problems have been experienced with such a respirator. It is difficult to incorporate the seals of the ocular and oronasal masks into the relatively small area defined by the size of the face of the wearer and so construction of the respirator is relatively complex and expensive. Furthermore, it is difficult to develop a seal on the ocular mask that fits all users due to the large variation of head and face shapes.

The respirator of the present invention overcomes some or all of these problems.

In accordance with the present invention, a respirator comprising  
a respirator facepiece,  
a first sealing means suitable for forming a seal on the face of a user so as to define a first cavity

between the first sealing means, the respirator facepiece and an area of the user's face comprising the eyes, mouth and nose,

a second sealing means suitable for forming a seal on the face of the user so as to define a second cavity, the second cavity being formed between a portion of the face of the user, the second sealing means, the first sealing means and optionally the respirator facepiece,  
 5 a respirator air inlet for conducting inhaling air to the first cavity,  
 a respirator air outlet for conducting exhaled air from the first cavity, and  
 an air pressure supply means suitable for supplying pressurised air to the second cavity

10 whereby in normal operation air is inhaled and exhaled solely through the first cavity and so substantially no air pressure differential exists between the ambient atmosphere and the second cavity which will allow ambient air to enter the second cavity.

This provides a respirator that in use provides a positive pressure in the cavity between the breathing  
 15 cavity and the ambient atmosphere such that, should the second sealing means fail, then the positive pressure in the outer cavity urges air away from the point of failure of the seal, thus reducing the likelihood of ingress of contaminant into the respirator.

The respirator preferably further comprises at least one eyepiece and a means for directing inhaling  
 20 air over the at least one eyepiece. The inhaling air helps to demist the eyepiece and/or prevent misting from occurring. The means for directing inhaling air over the at least one eyepiece may be capable of diverting some of the inhaling air directly to the oronasal region of the user. Such a means for directing inhaling air over the at least one eyepiece may be a baffle.

25 The respirator may further comprise exhaust deflection means capable of preventing exhaled air from contacting the at least one eyepiece. Exhaled air is warm and, unless inhibited, tends to rise over the eyepiece if the user's head is in an upright position. The exhaled air may be moisture-laden and could thus cause the eyepiece to mist. An exhaust deflection means is therefore of benefit to the user.

30 The exhaust deflection means may comprise a third sealing means that, in use, engages with the face of the user so as to form ocular and oronasal cavities, the third sealing means being provided with means for permitting gaseous flow from the oronasal cavity to the ocular cavity. The means for permitting gaseous flow from the oronasal cavity to the ocular cavity may take the form of a diffuser and/or merely passages in the third sealing means. The third sealing means should be arranged to  
 35 allow air flow from the ocular cavity to the oronasal cavity.

The respirator may further comprise a valve assembly comprising a valve body having a valve assembly outlet and a valve assembly inlet, and a valve cavity therebetween,

5 a valve mechanism for permitting gaseous flow through the valve assembly inlet into the valve cavity and to the valve assembly outlet,

a continuous purge outlet means connectable to an air pressure supply means,

an air deflection means spatially arranged in the valve cavity relative to the valve mechanism and the purge outlet means such that, on connection and activation of a suitable air pressure supply means, air is emitted from the purge outlet means and is incident on the air deflection means such that a curtain  
10 of air may be substantially maintained above the valve mechanism.

Such a valve assembly produces superior protection. For the avoidance of doubt, it is hereby stated that the air pressure supply means is not part of the valve assembly; the purge outlet is merely connectable to an air pressure supply means.

15

The respirator air inlet may be, in use, in gaseous communication with the first cavity, thus forming a first gaseous pathway,

a second air inlet is in gaseous communication with the air pressure supply means which is capable, in use, of providing gas to the second cavity, thus forming a second gaseous pathway.

20 wherein the first and second air inlets are located in a common filter connection means, and the filter connection means is connectable to a suitably adapted filter such that, in use, the first and second gaseous pathways are mutually isolated so that inhalation by the user does not substantially affect the pressure in the second gaseous pathway.

25 Such a respirator provides clean inhaled air and clean air to be supplied by the air pressure supply means through one respirator connection without increasing the work to be done by the air pressure supply means.

30 A second embodiment of the invention provides a sealing piece for a respirator, the sealing piece comprising first and second portions, each comprising a substantially compliant material and each having a respective sealing surface suitable for engagement with the face of a user so as to define a substantially sealed cavity between the sealing piece and the face of the user, the first and second portions being mutually connected by a third portion suitable for attachment to the surface of a respirator, the sealing piece further comprising a gas inlet for allowing, in use, the supply of  
35 pressurised gas to the cavity, and wherein the first and second portions are so shaped that, in use, the

application of a positive pressure in the cavity does not cause the seals to be broken.

5 The first and second portions are preferably shaped such that, in use, the application of a positive pressure in the cavity causes at least one of the first and second sealing surfaces to be urged into a more positive engagement with the face of the user.

The first and second portions are locally J or U shaped in section. It is preferred that at least one of the first and second portions comprises a reverse reflex seal.

10 The sealing piece may be used with a respirator of the first embodiment of the present invention.

In the traditional two cavity respirators of the prior art, a first sealing means is used to generate a first cavity that contains the oro-nasal region of the user, while a sealing means is used to define a second cavity, usually a space between the first sealing means, the second sealing means, the face of the user  
15 and the main body of the respirator. An air pressure supply means such as a bellows or electrical pump is used to provide the second cavity with pressurised air. This maintains a positive pressure in relation to the ambient atmosphere and, in the event that the second sealing means fails, then air from inside the second cavity urges out to the ambient atmosphere, reducing the likelihood of ingress of contaminated ambient atmosphere. The air pressure supply means has been arranged so as to draw air  
20 from the clean air that is to be inhaled into the first cavity as shown in WO02/11816. This simple system has the disadvantage that, on inhalation, the air pressure within the first cavity falls. The air pressure supply means is a constant volume pump that attempts to maintain a constant flow of air through the pump. A drop in pressure within the first cavity causes the pump to experience a drop in air pressure at the air intake of the pump, thus causing the pump to increase its work rate in order to  
25 try to maintain a constant flow of air into the second cavity. This reduces the battery life of the pump. Attempts were made to alleviate the problem of the respirator of the prior art. For example, the pump was arranged such that it would only function on exhalation of the user. However, this did not provide a satisfactory pressure in the second cavity throughout the whole breathing cycle of the user. In an alternative attempt to solve the problem of the prior art, the inlet to the pump was arranged to have a  
30 separate air intake and filter, divorced from the inhalation air pathway. The pump was provided with its own filter. While satisfactory in some aspects, this embodiment requires two separate filters and does not provide a satisfactory solution to the problem associated with the prior art.

In a third embodiment of the present invention, there is provided a respirator comprising  
35 a first seal means suitable for forming a seal on the face of a user so as to form a first cavity, the first cavity containing the oro-nasal region of the user,

a second seal means suitable for forming a seal on the face of a user so as to form a second cavity, an air pressure supply means in gaseous communication with a first air inlet and capable, in use, of providing gas to the second cavity, thus forming a first gaseous pathway, a second gaseous inlet which, in use, is in gaseous communication with the first cavity, thus forming a second gaseous pathway, the first and second air inlets being located in a common filter connection means, wherein the filter connection means is connectable to a suitably adapted filter such that in use the first and second gaseous pathways are mutually isolated so that inhalation by the user does not substantially affect the pressure in the first gaseous pathway.

10

It is preferred that the air pressure supply means is electrically operated. It is further preferred that the filter connection means comprises a safety interlock arranged such that the air pressure supply means may not be actuated unless a suitably adapted filter is fitted to the respirator. Such an interlock may be electrical. For example, the air pressure supply means may be in electrical communication with one or more contacts on the filter connections means. The filter to be fitted to the respirator may comprise one or more suitable electrical contacts that are brought into electrical communication with the contacts of the filter connection means of the respirator so as to form a complete electrical circuit, thus permitting the air pressure supply means and thus the respirator to function. In the absence of the filter the air pressure supply means is left in an open circuit mode and thus the air pressure supply means cannot operate. This also prevents the operation of the air pressure supply means when an inappropriate filter is fitted to the respirator. The safety interlock may alternatively and additionally be mechanical.

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The respirator above needs to be used with a suitably-adapted filter. In accordance with the present invention, there is provided a filter for a respirator, the filter comprising an inlet for the intake of a gas to be filtered, the inlet being in gaseous communication with a plurality of mutually discrete filtration zones, each filtration zone comprising a filtration material capable of removing unwanted species from the gas to be filtered wherein each filtration zone is in gaseous communication with an outlet, each outlet being in gaseous communication with only one filtration zone, the outlets being located in a common respirator connection means.

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The filter preferably comprises two filtration zones. It is preferred that the first filtration zone is of a circular section and the second filtration zone is of an annular section, the first filtration zone fitting snugly within the second.

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It is further preferred that the respirator connection means comprises a means for engaging with the safety interlock of an attached respirator such that the air pressure supply means of the attached respirator may be actuated when the filter is properly fitted to the respirator. The filter to be fitted to the respirator may comprise suitable electrical contacts that make electrical contact with the contacts of the respirator so as to form a complete electrical circuit, thus permitting the air pressure supply means and thus the respirator to function. In the absence of the filter the air pressure supply means is left in an open circuit mode and thus the air pressure supply means cannot operate.

WO02/11816 discloses the concept of a purging airflow around the base of a valve assembly to reduce the likelihood of ingress of contaminated and/or exhaled air back into the respirator. The applicant has developed an improved valve assembly that gives potentially improved protection.

A fourth embodiment of the present invention provides a valve assembly comprising a valve body having a valve assembly outlet and a valve assembly inlet, and a valve cavity therebetween, a valve mechanism for permitting gaseous flow through the valve assembly inlet into the valve cavity and to the valve assembly outlet, a continuous purge outlet means connectable to an air pressure supply means, an air deflection means spatially arranged in the valve cavity relative to the valve mechanism and the purge outlet means such that, on connection and activation of a suitable air pressure supply means, air is emitted from the purge outlet means and is incident on the air deflection means such that a curtain of air may be substantially maintained above the valve mechanism.

Such a valve assembly produces superior protection. For the avoidance of doubt, it is hereby stated that the air pressure supply means is not part of the valve assembly; the purge outlet is merely connectable to an air pressure supply means.

The air deflection means prevents air from mixing in the immediate vicinity of the valve mechanism and thus causing potentially harmful turbulent flow.

A curtain of air is defined as being a substantially unidirectional flow at any given point in the flow for as long as the air pressure supply means is functioning.

This provides a valve for use in many respirators.

It is preferred that the purge outlet is sufficiently displaced from the valve mechanism such that, in use, the pressure experienced in the valve cavity in the immediate vicinity of the valve mechanism does not cause the valve mechanism to allow air to flow from the valve cavity through the valve inlet to the interior of the respirator.

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It is preferred that the interior of the valve body is provided with a cylindrical bore, with the valve assembly inlet preferably being situated at or near one end of the bore. With the cylindrical bore, it is convenient for the purge outlet means to be an annular outlet around the circumference of the bore. If the purge outlet means is of an annular shape, then it is preferred that the air deflection means is a hollow or solid cylinder.

10

It is preferred that the purge outlet is in gaseous communication with a manifold. This is preferably of a sufficiently large volume to assist in the maintenance of a curtain of air above the valve mechanism.

15

The valve assembly may be provided with a plurality of outlet conduits, each outlet conduit providing a tortuous outlet path to the valve assembly outlet. The cross-section of the gaseous pathway defined by each conduit decreases nearer the valve assembly outlet. This causes acceleration of the gas away from the outlet. It is further preferred that the valve assembly comprises anti-swirl vanes that reduce the cyclonic motion of any air that may enter the valve assembly. The anti-swirl vanes preferably project substantially radially from the air deflection means.

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The valve assembly of the present invention may be used in accordance with the respirators of the present invention and any respirator having a means of supplying pressurised air to the valve assembly.

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The various embodiments of the present invention will now be described by way of example only with reference to the following figures of which:

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Figure 1 shows an anterior and posterior view of a respirator in accordance with the first embodiment of the present invention;

Figure 2 shows a perspective view of a section through a sealing component that is used in the respirator of figure 1;

Figure 3 shows a schematic representation of how the sealing component of the present invention may be constructed with respect to a respirator;

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Figure 4 shows a section through a valve assembly in accordance with the fourth embodiment of the present invention;

Figure 5 shows a schematic representation of a component part of the valve assembly of figure 4; and Figure 6 shows a schematic block diagram of a respirator in accordance with the first embodiment of the present invention.

5 Figure 1 shows a respirator in accordance with the first embodiment of the present invention. The respirator comprises a facepiece 1, eyepieces 2a and 2b, air outlet 3, air inlet 4, first seal 7 and second seal 6, exhaust deflection means 8, attachment lugs 9, 10, air guide 11, air pressure supply means (not shown) and diffuser 12. The respirator comprises a respirator facepiece 1, a first seal 7 suitable for forming a seal on the face of a user so as to define a first cavity between the first seal 7, the respirator  
10 facepiece 1 and an area of the user's face comprising the eyes, mouth and nose, a second seal 6 suitable for forming a seal on the face of the user so as to define a second cavity, the second cavity being formed between a portion of the face of the user, the second seal 6, the first seal 7 and optionally the respirator facepiece 1, an air inlet 4 for conducting inhaling air to the first cavity, an air outlet 3 for conducting exhaled air from the first cavity, and an air pressure supply means suitable for  
15 supplying pressurised air to the second cavity whereby in normal operation air is inhaled and exhaled solely through the first cavity and so substantially no air pressure differential exists between the ambient atmosphere and the second cavity which will allow ambient air to enter the second cavity.

The eyepieces 2a and 2b are made from transparent material and are placed in suitably sized cavities  
20 in the facepiece 1 to permit the wearer to see out of the respirator when in use. The eyepieces may be separate as shown in Figure 1 or may be formed in one piece. The eyepieces 2a, 2b are sealed into the facepiece 1 to inhibit ingress of ambient gas through the join between the eyepieces 2a, 2b and the facepiece 1 into the interior of the respirator.

25 The exhaust deflection means 8 reduces the likelihood of warm, moisture-laden exhaled air from coming into contact with the eyepieces 2a, 2b. In this embodiment, the exhaust deflection means takes the form of a bar or strip of substantially compliant material that, in use, fits across the bridge of the nose and cheekbones of the user to substantially isolate the oronasal region of the user from the ocular region. The bar or strip is formed on the back of a substantially rigid skirt (not shown) that is attached  
30 to the facepiece of the respirator. The skirt allows air to pass from the oronasal region to the ocular region via diffuser 12. The bar or strip does not extend the whole width between the two sides of first seal 7. A small gap is formed between first seal 7 and the skirt to allow air to flow between the ocular region and the oronasal region. Not only does the exhaust deflection means 8 reduce the likelihood of exhaled air passing over the eyepieces 2a, 2b, but it also helps control the flow of demisting air over  
35 the eyepieces 2a, 2b and into the oronasal region.

In use, the respirator is placed on the face of the user. The first seal 7 forms a seal on the face around part of the face comprising the eyes, nose and mouth, such that a first cavity is formed between the first seal 7, the facepiece 1 of the respirator and the face of the user. The second seal 6 forms an outer seal around the first seal 7 such that a second cavity is formed, the second cavity being defined by the first and second seals and a portion of the face of the user. Air is inhaled and exhaled solely through the first cavity and so substantially no air pressure differential exists between the ambient atmosphere and the second cavity which will allow ambient air to enter the second cavity.

In use, a filter (not shown) is mounted on the air inlet 4 and air is drawn through the air inlet 4 via the filter into the first cavity. Those skilled in the art will realise that the filter is not an essential element of this invention. Such filters are well known to those skilled in the art. Air may be drawn into the first cavity using negative or positive pressure. In a negative pressure respirator, the breathing action of the wearer reduces the air pressure in the first cavity relative to the ambient atmosphere. Air is then drawn through the air inlet from the ambient atmosphere (preferably through a filter) into the first cavity and then into lungs of the wearer. In a positive pressure respirator, a pump or fan (not shown) draw air into the first cavity to maintain a positive pressure therein.

Air drawn into the first cavity is directed by the air guide 11. The air guide 11 is a plastic duct attached to the facepiece 1 that diverts some of the inhaled air directly to the oronasal region of the user and some of the inhaled air to the gap in the exhaust deflection means to the diffuser 12. The air guide 11 may be arranged such that all inhaled air is initially directed to the diffuser 12 into the ocular region. The diffuser 12 causes the inhaled air to be passed over the eyepieces 2a, 2b. The inhaled air thus helps to keep the eyepieces free of mist or steam. The air then passes through the gaps between the first seal 7 and the exhaust deflection means back into the oronasal region to be inhaled by the user.

Exhaled air is exhausted to the ambient atmosphere via the air outlet 3. The air outlet 3 is fitted with a non-return valve and dead space (not shown) that inhibit ingress of contaminated air from the ambient atmosphere. Such valves and dead space arrangements are known to those skilled in the art.

During operation of the respirator, the air pressure supply means provides air to the second cavity (the cavity between the first and second seals) in order to maintain a positive pressure relative to the ambient atmosphere and thus reduce the likelihood of ingress of contaminated air into the second cavity.

The sealing piece 5 is shown in section in greater detail in figure 2 and comprises the first seal 7 connected to the second seal 6 and attachment lugs 9, 10. The sealing piece 5 comprises first and second portions 7, 6 each comprising a substantially compliant material and each having a respective sealing surface suitable for engagement with the face of a user so as to define a substantially sealed cavity between the sealing piece and the face of the user, the first and second portions 7, 6 being connected by a third portion 13 suitable for attachment to the surface of a respirator, the sealing piece further comprising a gas inlet for allowing, in use, the supply of pressurised gas to the cavity, wherein the first and second portions are so shaped that, in use, the application of a positive pressure in the cavity does not cause the seals to be broken. First seal 7 and second seal 6 are linked by a connecting section the surface 13 of which may be attached to the body of the respirator. Straps (not shown) may be attached to attachment lugs 9, 10 to enable snug fitting of the respirator to the head of the user.

Figure 3 shows how the sealing piece of the present invention may be incorporated into a respirator. Figure 3a shows that the second and first seals 6, 7 may be incorporated into a one-piece component. Figure 3b shows that the seals 6, 7 may be separately attached to the body of the respirator. The one piece component 5 is advantageous, however, in that it allows both the first and second seal to be incorporated into a relatively small space, reduces production costs and complexity and allows simple relative position of the first and second seals. The one-piece sealing component 5 is, of course, made in one piece. Figures 3c and 3d show further alternative embodiments of the arrangement of seals 6, 7.

The first seal 7 is a reverse reflex seal whereas second seal 6 is a standard reflex seal. On the application of a positive pressure within the cavity between the seals 6, 7, then the second seal 6 is urged into greater engagement with the face of the user.

25

The respirator may comprise an outlet valve assembly that is shown in section in figure 4. The valve assembly 20 comprises a valve body 25 having a valve assembly outlet and a valve assembly inlet, and a valve cavity 30 therebetween, a unidirectional valve mechanism 24 for permitting gaseous flow through the valve assembly inlet into the valve cavity 30 and to the valve assembly outlet, a continuous purge outlet 27 connectable to an air pressure supply means, an air deflector 28 spatially arranged in the valve cavity 30 relative to the unidirectional valve mechanism 24 and the purge outlet 27 such that, on connection and activation of a suitable air pressure supply means, air is emitted from the purge outlet 27 and is incident on the air deflector 28 such that a curtain of air 22 may be substantially maintained above the unidirectional valve mechanism 24. A cylindrical bore has been formed in the valve body 25 to generate the valve cavity 30. The valve assembly 20 is shown located within a respirator air outlet 3 located within a respirator facepiece 1. In use, exhaled air 21 is driven

through the unidirectional valve mechanism 24 that is located in the valve seat 23. The unidirectional valve mechanism 24 is typically a membrane. The unidirectional valve mechanism 24 inhibits flow of exhaled and ambient air through the valve assembly 20 into the respirator. A source of pressurised air, such as an air pump or bellows (not shown) is connected to the purge air inlet 31 that is in fluid communication with a manifold 26. The manifold 26 is annular in shape and is in fluidic communication with the purge outlet 27. In use, the source of pressurised air provides pressurised air to the manifold 26. The pressurised air then passes to the purge outlet 27 that, in this case, is an annular shape. The outlet 27 is continuous around the circumference of the inner surface of the valve body 25. Air is urged from the purge outlet 27 in the form of a curtain of air 22 above the unidirectional valve mechanism 24. Such an arrangement inhibits the accumulation of exhaled air 21 or ambient air in the region of the unidirectional valve mechanism 24 and urges any potentially contaminated air away from the user, thus reducing the likelihood of any unwanted gas ingress into the respirator. The purge outlet 27 should not be positioned too close to the unidirectional valve mechanism 24 since moving air creates regions of low pressure adjacent to the moving air. If such a region of low pressure is too close to the unidirectional valve mechanism 24, then the membrane of the mechanism lifts, thereby permitting air in the proximity of the valve mechanism 24 to be breathed in by the user. The shape and size of the purge outlet 27 dictate the angle at which the air is emitted from the purge outlet 27. The air deflector 28 enables the formation of a curtain of air 22 above the unidirectional valve mechanism 24. After passing through the purge outlet 27, the air is directed onto the air deflector 28. The position, shape and size of the air deflector 28 are chosen so that there is no or little turbulent air flow in the air emitted through the purge outlet 27 in the region above the unidirectional valve mechanism 27. The curtain of air 22 is deflected by the air deflector 28 to conduit 41a. In the present case, the air deflector 28 is cylindrical in shape.

The conduit 41a is one of six provided by a deadspace protection component 45 shown in detail in figure 5. The air deflector 28 is shown in figure 5 merely to illustrate the spatial relationship between the air deflector 28 and the deadspace protection component 45. The air deflector 28 is not part of the deadspace protection component 45. The six conduits are provided by a series of six guide walls. For clarity and ease of reference only one conduit 41a and two guide walls 42a, 42b are labelled. Exhaled air and the purging curtain of air pass to the inlet 46a of the conduit 41a. The walls 42a, 42b radiate from the central cavity of the valve assembly to the valve outlet 40a in a spiral manner. The spiralling nature of the conduit 41a increases the gaseous path length between the ambient atmosphere and the unidirectional valve mechanism 24, thus reducing the likelihood of unwanted ingress of ambient gas. The cross-section of the conduit 41a decreases the closer the conduit is to the ambient atmosphere. This accelerates exhaled air and purging air outwards, thus reducing the likelihood of unwanted ambient gas ingress. The exhaled and purging air exits each conduit via a small valve outlet 40a. The

conduit 41a is shaped so as to turn any exhaled and purging air, and more importantly any incoming air, out of the plane of the spiral. This effectively turns the air through mutually perpendicular directions. This slows down any incoming air. The guide walls 42a, 42b are each provided with a radial projection 43a, 43b that slows any incoming air and helps to prevent a cyclonic motion of air from building-up within the valve assembly, should air be driven into the valve outlets. The use of multiple small valve outlets as opposed to one large vent decreases the risk of wind-blown ingress of ambient gas.

The curtain of air 22 may be provided continuously or during the inhalation process when ingress of contaminants is likely to occur.

Air deflector 28 may be provided with radially projecting vanes 47. These further help to prevent the build-up of cyclonic air motion within the valve assembly 20.

Those skilled in the art will realise that the outlet valve assembly of figures 4 and 5 is compatible with innumerable respirators and its use is not limited to use with the respirators of the present invention.

A possible arrangement of the respirator of the first embodiment of the present invention is shown in figure 6. The respirator air inlet 55 is, in use, in gaseous communication with the first cavity 52, thus forming a first gaseous pathway, a second air inlet 54 is in gaseous communication with the air pressure supply means 53 which is capable, in use, of providing gas to the second cavity 51, thus forming a second gaseous pathway, wherein the respirator and second air inlets are located in a common filter connection means 57, and the filter connection means 57 is connectable to a suitably adapted filter 60 such that in use the first and second gaseous pathways are mutually isolated so that inhalation by the user does not substantially affect the pressure in the second gaseous pathway.

Referring to figure 1, the first cavity 52 is formed between the first seal 7, the facepiece 1 and the face of the user. The second cavity 51 is formed between the second seal 6, the first seal 7 and a portion of the face of the user. A valve 56 is situated in the first gaseous pathway to prevent contaminated air from reaching the first cavity 52. The filter 60 has been adapted to mate with the respirator of the present invention. The filter 60 comprises first and second filter air inlets 62, 63, filtration material 61, first and second filter air outlets 64, 65 and respirator connection means 66. The first and second filter air outlets 64, 65 are located in a common respirator connection means 66. In use, air is drawn through the first filter air inlet 62, through the filtration material to the first filter air outlet 64. Air passes into the respirator via the second air inlet 54 into the second cavity 51. Similarly, air is drawn through the second filter air inlet 63, through the filtration material to the second filter air outlet 65. Inhaling air is drawn from the second filter air outlet 65 to the respirator air inlet 55 into the first

cavity 52 and then into the lungs of the user. The gaseous pathway through the first filter air inlet to the first filter air outlet is isolated from that through the second filter air inlet to the second filter air outlet. Thus, inhalation by the user does not affect the pressure in the second gaseous pathway and so the air pressure supply means 53 is not exposed to a drop in pressure and thus does not have to increase its energy consumption in order to maintain the required pressure in the second cavity 51.

The respirator connection means comprises a means for engaging with the safety interlock of an attached respirator (not shown) such that the air pressure supply means of the attached respirator may be actuated when the filter is properly fitted to the respirator. The filter to be fitted to the respirator may comprise suitable electrical contacts that mate with the contacts of the respirator so as to form a complete electrical circuit, thus permitting the air pressure supply means and thus the respirator to function. In the absence of the filter the air pressure supply means is left in an open circuit mode and thus the air pressure supply means cannot operate.



## Claims

1. A respirator comprising  
a respirator facepiece,  
5 a first sealing means suitable for forming a seal on the face of a user so as to define a first cavity  
between the first sealing means, the respirator facepiece and an area of the user's face comprising  
the eyes, mouth and nose,  
a second sealing means suitable for forming a seal on the face of the user so as to define a second  
cavity, the second cavity being formed between the second sealing means, the first sealing means,  
10 a portion of the face of the user and optionally the respirator facepiece,  
a respirator air inlet for conducting inhaling air to the first cavity,  
a respirator air outlet for conducting exhaled air from the first cavity, and  
an air pressure supply means suitable for supplying pressurised air to the second cavity  
  
15 whereby in normal operation air is inhaled and exhaled solely through the first cavity and so  
substantially no air pressure differential exists between the ambient atmosphere and the second  
cavity which will allow ambient air to enter the second cavity.
2. A respirator according to claim 1 further comprising at least one eyepiece and a means for  
20 directing inhaling air over the at least one eyepiece.
3. A respirator according to claim 2 further wherein the means for directing inhaling air over the at  
least one eyepiece is capable of diverting some of the inhaling air directly to the oronasal region  
of the user.  
25
4. A respirator according to either of claims 2 and 3 further comprising exhaust deflection means  
capable of preventing exhaled air from contacting the at least one eyepiece.
5. A respirator according to claim 4 wherein the exhaust deflection means comprises a third sealing  
30 means that, in use, engages with the face of the user so as to form ocular and oronasal cavities, the  
third sealing means being provided with means for permitting gaseous flow from the oronasal  
cavity to the ocular cavity.
6. A respirator according to any one preceding claim further comprising a valve assembly  
35 comprising  
a valve body having a valve assembly outlet and a valve assembly inlet, and a valve cavity

therebetween,

a valve mechanism for permitting gaseous flow through the valve assembly inlet into the valve cavity and to the valve assembly outlet,

a continuous purge outlet means connectable to an air pressure supply means,

5 an air deflection means spatially arranged in the valve cavity relative to the valve mechanism and the purge outlet means such that, on connection and activation of a suitable air pressure supply means, air is emitted from the purge outlet means and is incident on the air deflection means such that a curtain of air may be substantially maintained above the valve mechanism.

10 7. A respirator according to any one preceding claim wherein the respirator air inlet is, in use, in gaseous communication with the first cavity, thus forming a first gaseous pathway, a second air inlet is in gaseous communication with the air pressure supply means which is capable, in use, of providing gas to the second cavity, thus forming a second gaseous pathway, wherein the first and second air inlets are located in a common filter connection means, and the  
15 filter connection means is connectable to a suitably adapted filter such that in use the first and second gaseous pathways are mutually isolated so that inhalation by the user does not substantially affect the pressure in the second gaseous pathway.

20 8. A sealing piece for a respirator, the sealing piece comprising first and second portions, each comprising a substantially compliant material and each having a respective sealing surface suitable for engagement with the face of a user so as to define a substantially sealed cavity between the sealing piece and the face of the user, the first and second portions being mutually connected by a third portion suitable for attachment to the surface of a respirator, the sealing piece further comprising a gas inlet for allowing, in use, the supply of pressurised gas to the  
25 cavity, and wherein the first and second portions are so shaped that, in use, the application of a positive pressure in the cavity does not cause the seals to be broken.

30 9. A sealing piece according to claim 8 wherein, in use, the application of a positive pressure in the cavity causes at least one of the first and second sealing surfaces to be urged into a more positive engagement with the face of the user.

10. A sealing piece according to either of claims 8 and 9 wherein the first and second portions are locally J or U shaped in section.

11. A sealing piece according to any one of claims 8 to 10 wherein at least one of the first and second portions comprises a reverse reflex seal.

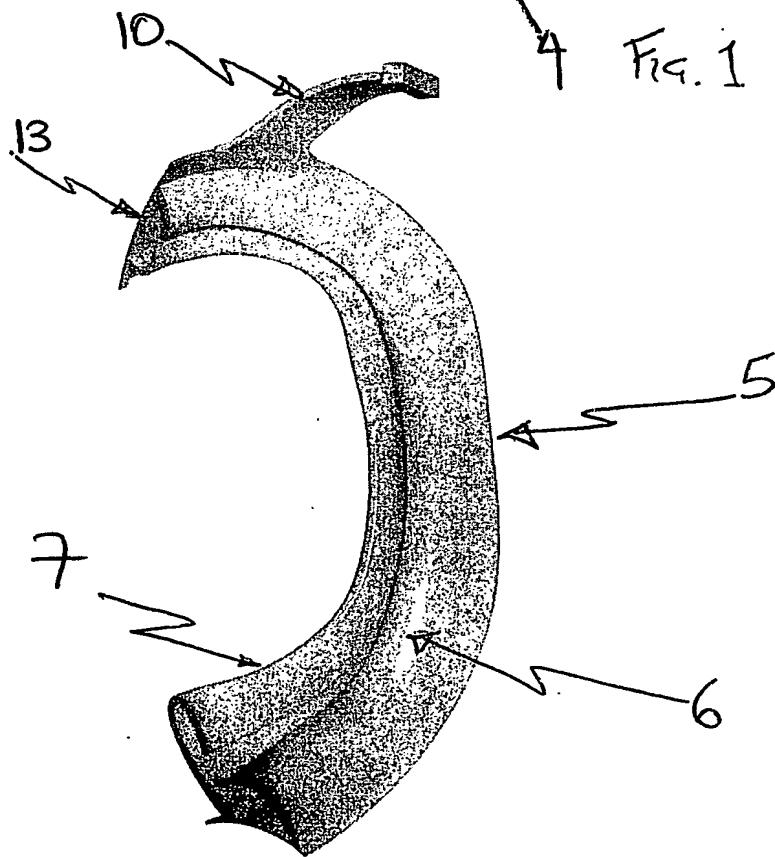
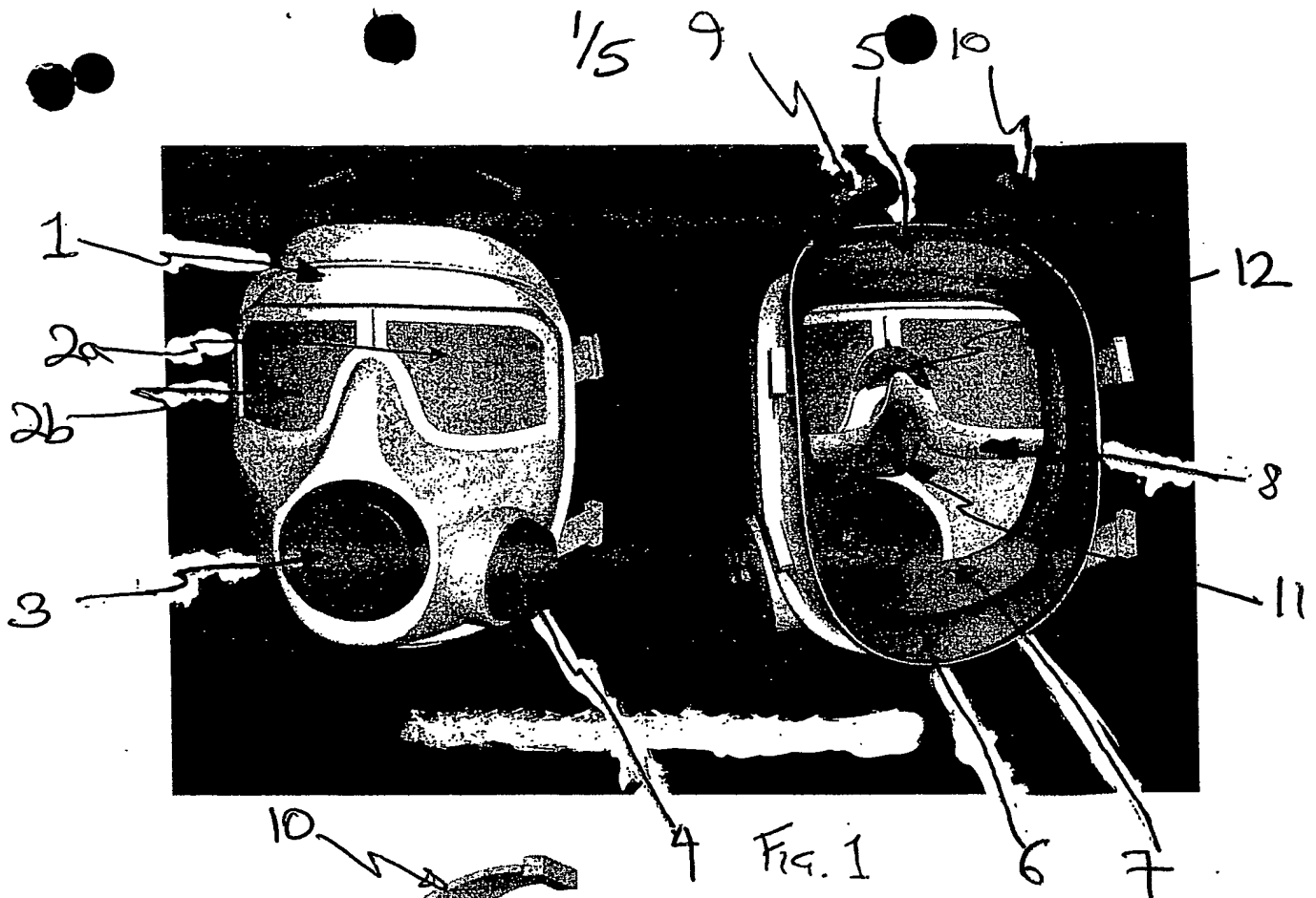
12. A respirator comprising a sealing piece in accordance with any one of claims 8 to 10.

5

13. A respirator substantially as hereinbefore described with reference to the accompanying figures.

## Abstract

- A respirator comprising
- a respirator facepiece,
- 5 a first sealing means suitable for forming a seal on the face of a user so as to define a first cavity between the first sealing means, the respirator facepiece and an area of the user's face comprising the eyes, mouth and nose,
- a second sealing means suitable for forming a seal on the face of the user so as to define a second cavity, the second cavity being formed between the second sealing means, the first sealing means, a
- 10 portion of the face of the user and optionally the respirator facepiece,
- a respirator air inlet for conducting inhaling air to the first cavity,
- a respirator air outlet for conducting exhaled air from the first cavity, and
- an air pressure supply means suitable for supplying pressurised air to the second cavity
- 15 whereby in normal operation air is inhaled and exhaled solely through the first cavity and so substantially no air pressure differential exists between the ambient atmosphere and the second cavity which will allow ambient air to enter the second cavity.



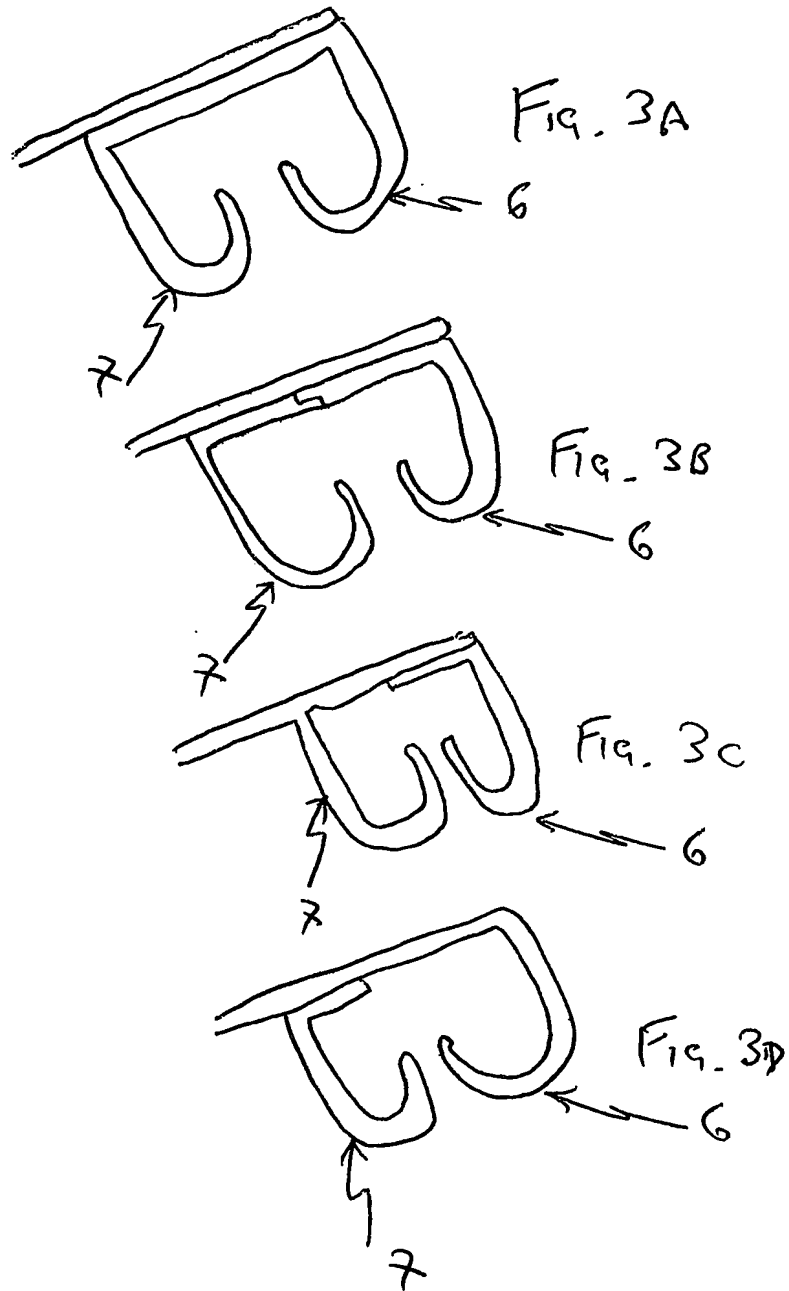


FIGURE 3

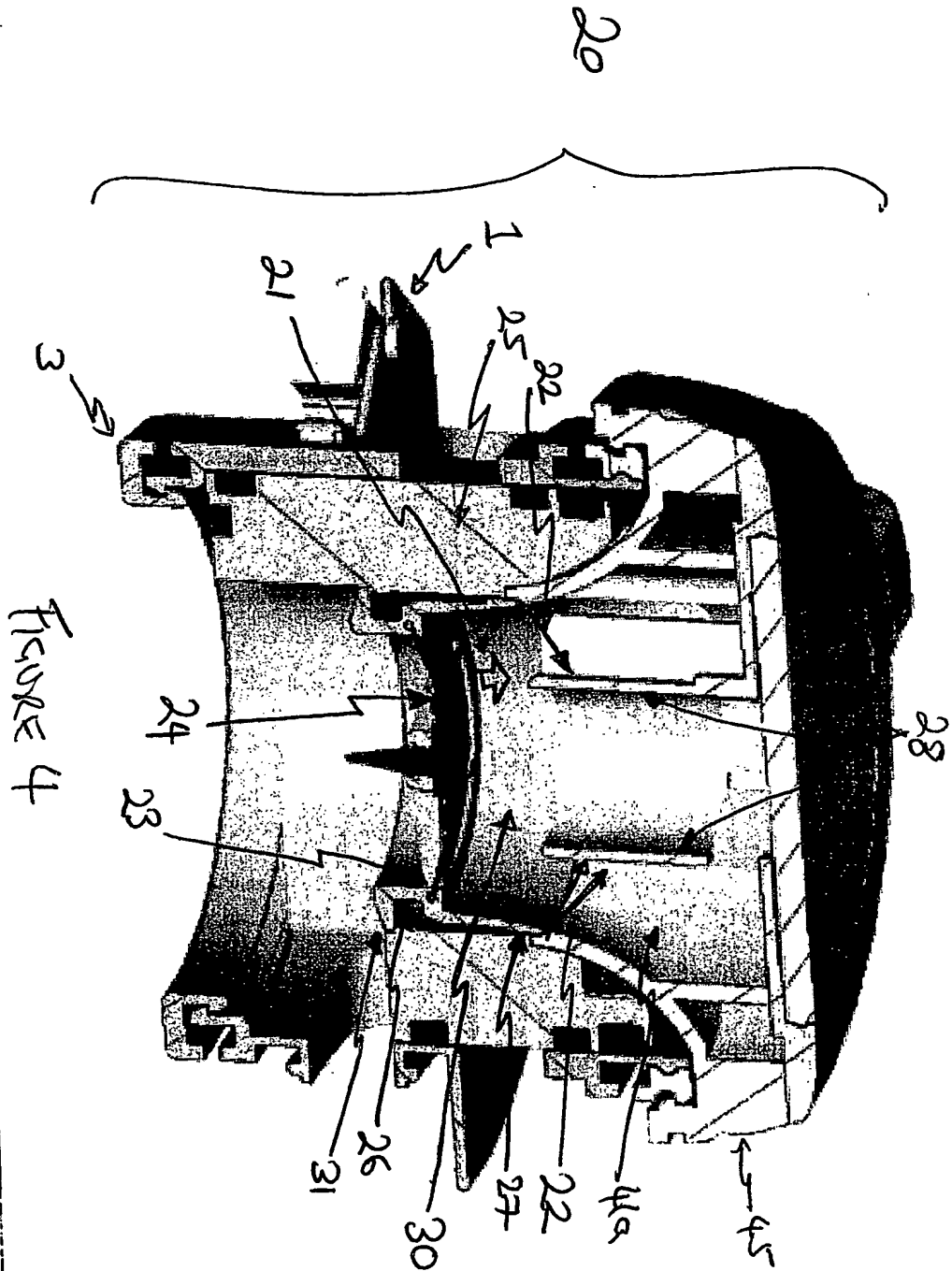


FIGURE 4

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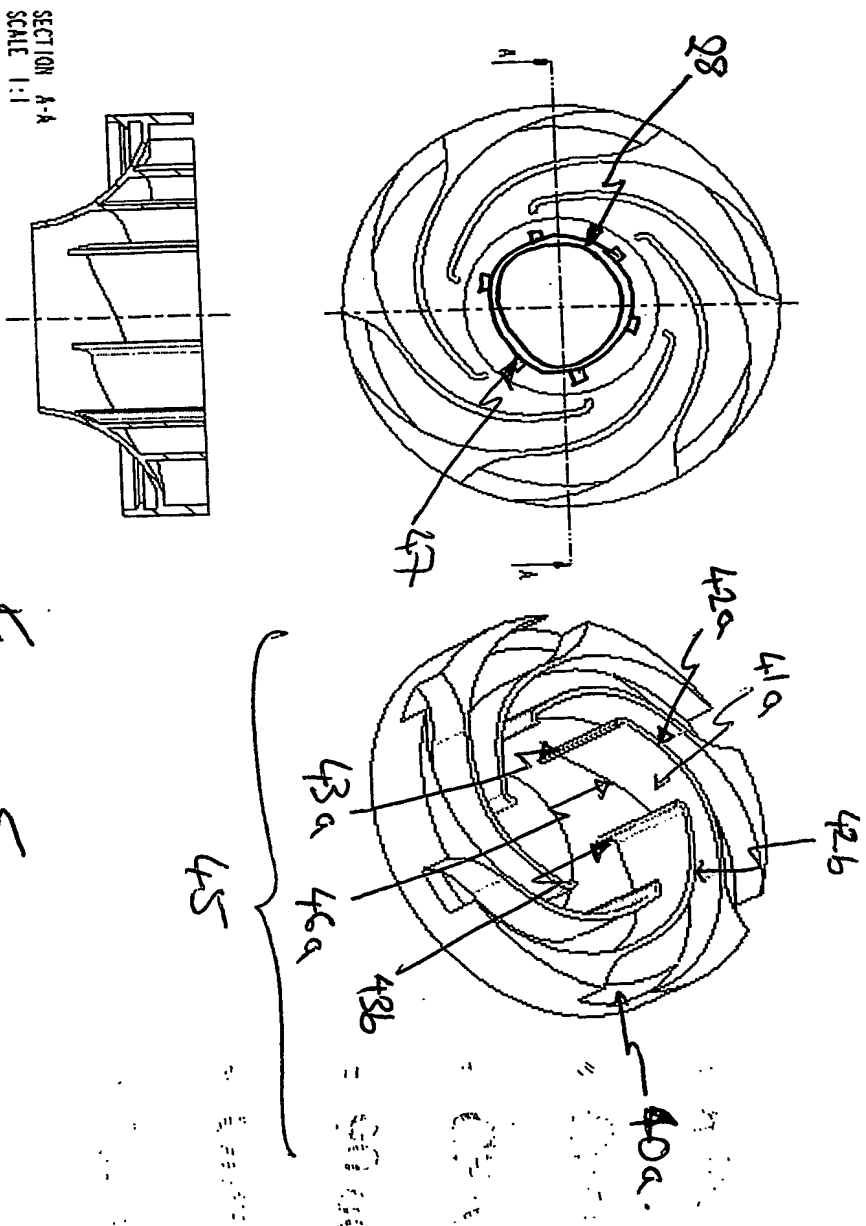


Figure 5



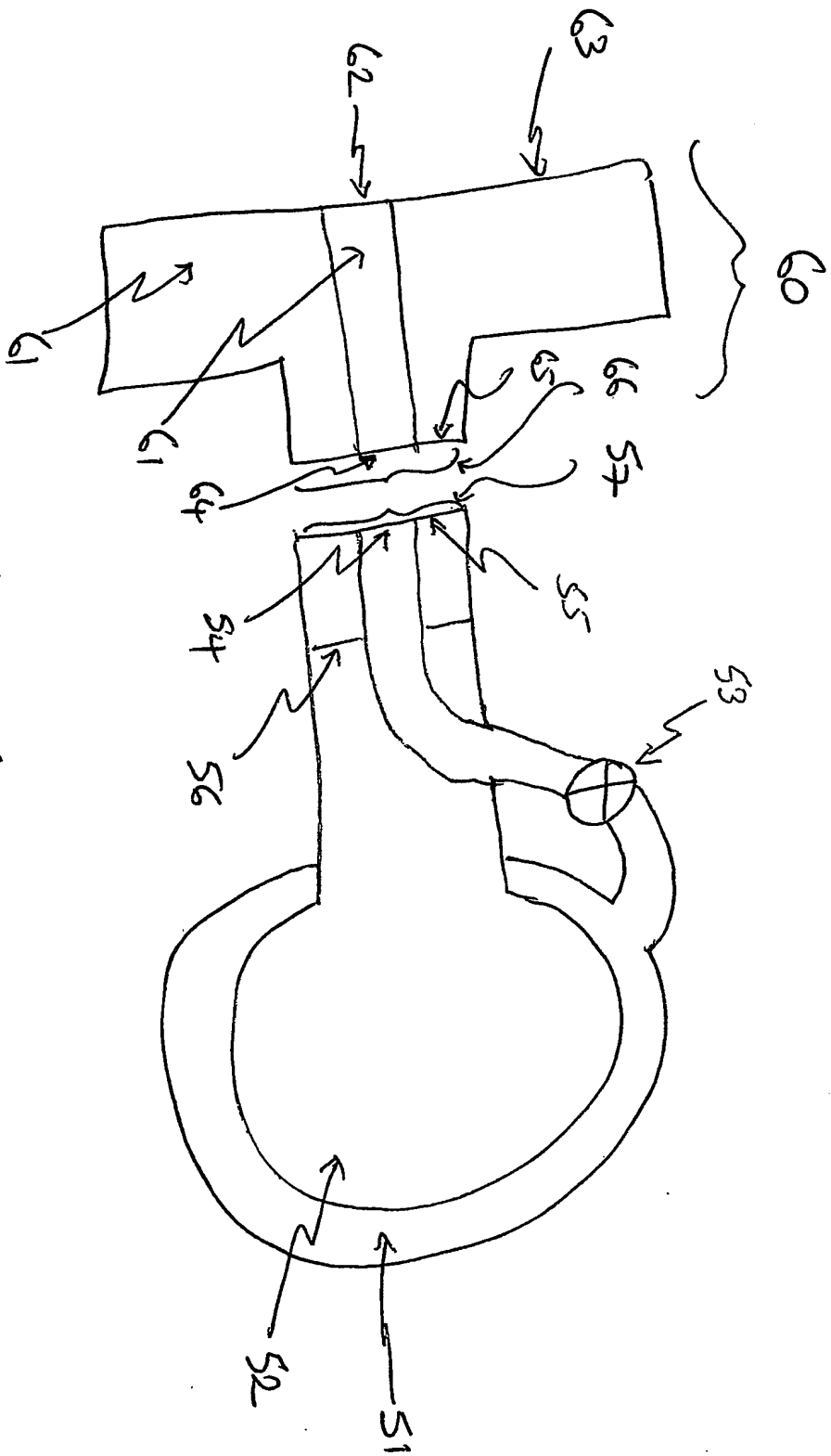


FIGURE 6.

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